Heat Wave Risk Assessment

This plan is an update of the 2004 City of Redmond Hazard Mitigation Plan (HMP). Although it is an update, this document has been redesigned so that it looks, feels, and reads differently than the original. This is due to several factors: new hazard information has become available that drives new definitions of risk, the City has matured and new capabilities are now available, and the new format will allow readers to more easily understand the content. In addition, the 2004 HMP included several action items that have been completed, creating an opportunity for developing new mitigation strategies.

10.1 Identifying Heat Wave Hazards

A heat wave is commonly defined as a period of abnormal, uncomfortably hot weather. The maximum daytime Heat Index (HI) defines a heat wave by combining temperature with humidity to calculate how hot it feels. Locally, daytime temperatures in the 90s are a problem. Since the Pacific Northwest does not typically experience such extreme temperatures, people do not have air conditioning and bodies are stressed by several days of heat in the 90s or above. Periods that do not cool down at night are particularly harmful. Since the 1970s, an average of three to four deaths occur annually. In 1992, an excessively warm summer was linked to 50-60 deaths.[111]

Heat waves are typically more severe in urban areas with stagnant atmospheric conditions and in areas with high levels of humidity. Heat waves occur every summer in many parts of the United States. Increased high temperatures may also lead to wildfires and drought.

10.2 Profiling Heat Wave Hazard Events

A. Location

In the event of a heat wave, all areas of Redmond will be affected. Redmond's temperate climate and suburban setting are generally not conducive to heat waves. The general lack of residential air conditioning will increase the impacts of irregularly high temperatures.

B. Timing and Duration

Heat waves occur in the summer months and generally can be predicted through weather monitoring. Two consecutive days of temperatures above 90°F triggers the National Weather Service Heat Advisory. Typical hot weather in Redmond is in the low 90°F range and generally lasts for a maximum of four days.[112]

111 National Weather Service, "Heat Wave: A Major Summer Killer," National Oceanic and Atmospheric Administration (NOAA), http://www.nws.noaa.gov/om/brochures/heat_wave.shtml.
112 Office of the Washington State Climatologist, Temperature data from 1999-2008, Courtesy of Karin Bumbaco. Assistant State Climatologist.

C. Severity

According to temperature data from the Office of the Washington State Climatologist, the average Redmond area temperature is 76°F. The highest summer temperatures in 2000-2008 in the Redmond area are displayed in Figure 7. In 2006 and 2007, Redmond experienced historic highs of 95°F.[113] Redmond's record high temperature is below the National Weather Service's alert temperature of 105°F. However, due to the generally mild climate, several days in the 95°F range would have a significant impact on the City.

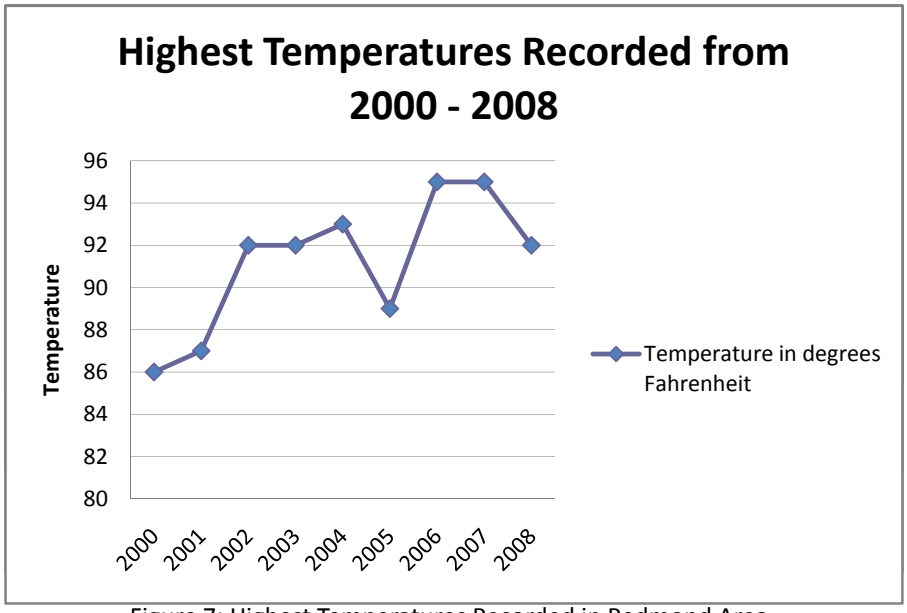


Figure 7: Highest Temperatures Recorded in Redmond Area
Source: Data from the Office of the Washington State Climatologist

D. Frequency

Previous Occurrences

Redmond has never experienced a heat wave as defined by the National Weather Service. However, Redmond has experienced temperatures in the upper 90s that have lasted for several days, in both 1992 and in 2009, with a new record high temperature of 103 degrees.

Probability of Future Events:

Climate change trends will increase the number of hot weather days in Redmond. Predictions indicate that average temperatures will increase 2°F by 2020.[114] Temperature fluctuations will be more extreme, potentially increasing temperatures in the Redmond area to higher levels that would trigger a National Weather Service alert. Climate change information also suggests that increasing temperatures will affect urban and rural areas similarly. In the future, Redmond may not be insulated from heat waves as it has been in the past.[115]

10.3 Assessing Heat Wave Vulnerability

113 Ibid.
114 Climate Impacts Group, "Climate Change Scenarios," University of Washington, http://cses.washington.edu/cig/fpt/ccscenarios.shtml#caveats.
115 Climate Impacts Group, "Climate Change Scenarios," University of Washington, http://cses.washington.edu/cig/fpt/ccscenarios.shtml#caveats.

10.3.1 Overview

Currently, extremely high temperatures are rare in the Pacific Northwest and thus Redmond is not particularly vulnerable. However, as the climate changes, heat waves are an anticipated hazard. In the event of a heat wave in Redmond, human populations, the natural environment and energy systems may be affected. Since Redmond is unaccustomed to heat waves, temperatures in the 90s may have impacts, even though such an event would not trigger a National Weather Service alert.

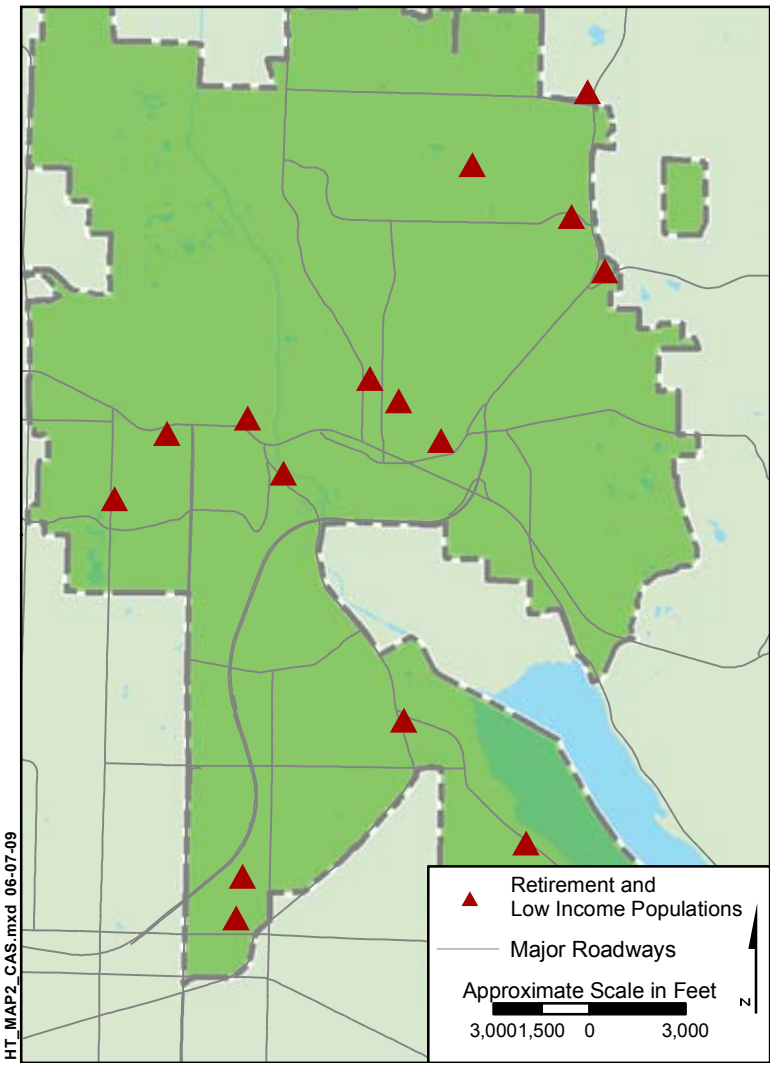
10.3.2 Profiling the Vulnerabilities

A. Man-made
Built structures are not vulnerable to heat waves.

B. Natural
In the event of a heat wave, some crop growth may be impacted if the heat occurs during the plant's early development stages. If a drought accompanies a heat wave, water shortages will impact crop and other vegetation growth. Extreme high temperatures may also increase the likelihood of wildfires. Heat waves can increase temperatures in streams and rivers, which could lead to changes in migration timing, reduce growth rates and reduce available oxygen for local fish species.[116]

C. Systems
Extremely high temperatures will increase water usage. The water supply is vulnerable to overuse during a heat wave. High temperatures can soften of asphalt or buckle concrete. Such damage to the roadways would lead to regional transportation problems.[117]

Retirement Homes and Low Income Populations
Source: King County



Map 32: Retirement Homes and Low Income Populations

D. Populations
The body cannot easily compensate with overexposure to heat. Heat-related illnesses include fatigue, dehydration, heat

116 National Wildlife Federation,"A Great Wave Rising: Solutions for Columbia and Snake River Salmon in the Age of Global Warming," http://www.nwf.org/GlobalWarming/pdfs/AGreatWaveRising.pdf.
117 Cooperative Institute for Research in the Atmosphere, "Impacts of Temperature Extremes," http://sciencepolicy.colorado.edu/socasp/weather1/adams.html.

exhaustion and heat stroke. In a normal year, about 175 Americans die from the summer heat.[118]

Hazard Specific
People without access to cooling devices such as air conditioning may be more vulnerable during a heat wave.

Isolated Populations
Since there will be little structural damage during a heat wave, people will not become isolated.

Disabled Persons
Disabled persons with compromised immune systems may have an increased risk.

Elderly
High temperatures require the human heart to work harder to pump blood toward the skin to help regulate body temperature. Elderly populations, especially those with heart conditions, will be more impacted by heat waves.[119]

Temperature (°F)

Relative Humidity (%)	80	82	84	86	88	90	92	94	96	98	100	102	104	106	108	110
40	80	81	83	85	88	91	94	97	101	105	109	114	119	124	130	136
45	80	82	84	87	89	93	96	100	104	109	114	119	124	130	137	
50	81	83	85	88	91	95	99	103	108	113	118	124	131	137		
55	81	84	86	89	93	97	101	106	112	117	124	130	137			
60	82	84	88	91	95	100	105	110	116	123	129	137				
65	82	85	89	93	98	103	108	114	121	128	136					
70	83	86	90	95	100	105	112	119	126	134						
75	84	88	92	97	103	109	116	124	132							
80	84	89	94	100	106	113	121	129								
85	85	90	96	102	110	117	126	135								
90	86	91	98	105	113	122	131									
95	86	93	100	108	117	127										
100	87	95	103	112	121	132										

Likelihood of Heat Disorders with Prolonged Exposure or Strenuous Activity
Caution Extreme Caution Danger Extreme Danger

Table 18: Likelihood of Heat Disorders Based on Temperature and Relative Humidity
Source: National Oceanic and Atmospheric Administration, "National Weather Service Heat Index," http://www.nws.noaa.gov/om/heat/index.shtml.

Limited English Language
Non-English speaking populations will not be particularly vulnerable to heat waves.

Low-income Residents
Low-income residents may be more impacted by heat waves if they do not have access to air-conditioning.

10.3.3 Analyzing Development Trends

Development and paved surfaces increase local surface temperatures. Urban areas create localized "heat islands"; increased development in Redmond will amplify this effect. If heat waves are accompanied by water shortages, population increases will correlate to water demand.

118 National Weather Service, "Heat Wave: A Major Summer Killer," National Oceanic and Atmospheric Administration (NOAA), http://www.nws.noaa.gov/om/brochures/heat_wave.shtml.
119 Cooperative Institute for Research in the Atmosphere, "Impacts of Temperature Extremes," http://sciencepolicy.colorado.edu/socasp/weather1/adams.html.